5. *Distribution of Colors among the Stars of N. G. C. 1647 and M. 67:* Frederick H. Seares and Harlow Shapley, Mount Wilson Solar Observatory, Carnegie Institution of Washington.

Neither N. G. C. 1647 nor M 67 show any dependence of condensation upon color which can not be explained on the basis of included background stars; there seems to be little, if any, dependence of condensation upon magnitude; but there is a marked relation between color and magnitude in N. G. C. 1647 and a less pronounced relation in M 67.

6. *On Thiele's "Phase" in Band Spectra:* Horace Scudder Uhler, Sloane Physical Laboratory, Yale University.

The author outlines an interpolation method for determining c in the formula $\lambda = f[(n+c)^2]$, which is much simpler than using Thiele's complicated formula.

7. *Why Polar Bodies Do Not Develop:* Edwin G. Conklin, Department of Biology, Princeton University.

The second or internal factor in normal fertilization is a non-diffusible substance which is introduced by the spermatozoon, and it is strongly suggested that this factor is the sperm centrosome, a position which Boveri has long maintained and which the author has hitherto contested. Giant polar bodies do not develop because they are not fertilized and they are not fertilized because they are generally formed after a spermatozoon has entered the egg and has rendered it impervious to other spermatozoa.

8. *Radical Velocities of the Planetary and Irregular Nebulæ:* W. W. Campbell and J. H. Moore, Lick Observatory, University of California.

The fact that the gaseous nebulæ have motions which are characteristic of the stars, and their concentration in the Milky Way, indicate that these nebulæ are members of our stellar system. The great velocities of the nebulæ in the Magellanic Clouds and other considerations lead to the hypothesis that the Magellanic Clouds are isolated cosmic units with no apparent connection with our own stellar system.

E. B. Wilson

SOME CORRELATIONS BETWEEN VEGETATION AND SOILS, INDICATED BY CENSUS STATISTICS

Although most persons who have lived or traveled extensively in the rural districts of the eastern United States have probably noticed that the proportion of evergreens in the forests is usually greatest on the poorest soils, and *vice versa,* one rarely sees any mention of such a correlation in scientific, especially ecological, literature. Most plant ecologists who have taken notice of evergreens at all seem to try to correlate them with climate in some way; but the easily demonstrated fact that two areas so close together or so similarly situated that they must have essentially the same climate often differ greatly in their percentage of evergreens shows that climate is not the only factor.[1]

The making of definite correlations between evergreens (or other aspects of vegetation) and soils has always been difficult on account of the dearth of quantitative data. No reliable quantitative analysis of the vegetation of a whole state has yet been made, and it would take many years to do such a piece of work thoroughly. To estimate the average composition, either physical or chemical, of the soils of an area of more than a few square miles would be even more difficult, for no matter how many samples were collected and analyzed, the judgment of the persons selecting them would always introduce a "personal equation" factor, unless the samples were selected wholly fortuitously, or at regular intervals (for example, at the corners or centers of every section of land).

Our knowledge of the chemical composition of the soils of the United States is still far from satisfactory. In Bulletins 57 and 85 of the U. S. Bureau of Soils are summed up most of the available chemical analyses, by states, and for some states there are only two or three, and those probably not typical; and they are not all made by the same methods. In fact soil investigators are not yet agreed on what method gives the best indication of

[1] In this connection see Torreya 13: 244. 1913, *Rep. Mich. Acad. Sci.,* 15: 196–197, 1914; *Ann. Rep. Fla. Geol. Surv.,* 6: 175, 393–396, 1914.

productivity, or correlates best with the native vegetation.

In the reports of the Census Bureau there are statistics, made so thoroughly as to practically eliminate the personal equation, that throw valuable light on both evergreen percentages and soil fertility. The percentage of evergreens is one of the most conspicuous and easily determined features of vegetation that can be expressed numerically, and it is almost the only one (and certainly the most significant one) that can be calculated from existing census statistics.

In 1911 the U. S. Census Bureau and Forest Service jointly published an octavo bulletin (without a number) entitled "Forest Products of the United States, 1909," giving among other things the output of lumber, laths and shingles by the sawmills of the United States in the year named, by states and by species simultaneously. Similar statistics have been published for subsequent years, but those for 1909, which were gathered in connection with the regular decennial census, seem to be the most complete.

Other things being equal, the lumber sawn from deciduous and evergreen trees in a given area should be proportional to the percentage of those trees in the forests; but other things are not equal. In the first place, it is of course the percentage of evergreens in the primeval forests that counts, and as the deciduous trees prefer the richer soils, a larger proportion of them than of the evergreens have been destroyed by farmers in clearing land for cultivation. Second, the evergreens in the United States are mostly (counting individuals, not species) conifers, and conifers on account of their gregarious habit and straight-grained easily worked wood are more sought after by lumbermen than the hardwoods are.

In the census statistics of lumber production all the hardwood trees listed are deciduous. (Some evergreen hardwoods are cut in the southeastern states, but in insignificant quantities.) The figures for evergreens are therefore obtained by subtracting from the total for conifers those for the two deciduous genera, *Taxodium* and *Larix* (cypress and tamarack). To make allowance for the hardwoods that have been destroyed by farmers, and the neglect of the remaining ones by lumbermen, the figures for them (not for all deciduous trees) are arbitrarily multiplied by 4. This product added to the figures for conifers and divided into the total evergreens (not total conifers) gives a percentage which is believed to approximate pretty closely in most cases the percentage of evergreens in the original forests.

Some idea of the fertility of the soil in different parts of the country can be obtained from several different sets of figures in the census reports. In rural districts there is a close relation between soil fertility and density of population; but in the northeastern states so large a population is supported by manufacturing, independently of the subjacent soil, that statistics of population there would be of very little use in this connection. Figures showing the value of land are open to the same objection.

The census gives the acreage of "improved land" in the farms of each state and county, and that is undoubtedly correlated with soil fertility, whether the fertility is due to physical or chemical conditions or something else; and the tendency to utilize the land more fully in the neighborhood of cities is partly offset by the occupation of much land for other purposes than farming, and such land is not included under "improved land in farms." For the purposes of this investigation the statistics of improved land have been taken from the Tenth Census (1880), because earlier censuses are probably less complete, and because the use of commercial fertilizers has increased so much since then as to tend to obliterate differences in productivity between different kinds of soil.[2]

Another kind of statistics given for each state and county in recent census reports is the

[2] In the South some sandy soils which were regarded as almost worthless half a century ago are valued more highly at the present time than the rich clayey or calcareous soils, because they are more easily tilled, and yield large returns for the amounts invested in fertilizers.

expenditure for fertilizers for the year preceding that in which the census was taken. The ratio between that and the total acreage of improved land is certainly a function of the natural fertility of the soil, although it is of course governed by some other factors as well.[3] If we determine the relative fertility of different states or counties by striking an average between the results obtained from a study of the percentage of improved land and the amount of fertilizer used per acre perhaps we shall not be far wrong; and still greater accuracy might be obtained by using additional criteria of an analogous nature.

The present study is limited to the eastern half of the United States; because in the West farming is chiefly confined to areas originally treeless, and there is no necessary connection between the fertility of such areas and the composition of the forests in the same states, which may occupy very different soils. Massachusetts, Rhode Island and Connecticut are omitted because their large urban population, deriving most of its food from the farms of other states, complicates matters too much; New Jersey for a similar reason and also because its most abundant evergreen, *Pinus rigida,* is of little value for lumber and therefore does not figure very largely in the returns; and Illinois, Iowa and Minnesota for the same reason as the western states.

In the table below the 24 remaining states are arranged in the order of their evergreen percentages, as determined in the manner above described, with the highest first. The first column of figures contains these percentages, the second the percentage of the total area "improved" in 1880, and the third the amount spent for fertilizer in 1909 for each acre of improved land reported in April, 1910. The last column gives the average rank of the states as determined by columns 2 and 3. *E. g.,* Florida ranks first in proportion of unimproved land, and second in the use of fertilizer per acre, making its average rank 1½.

States	Per Cent. of Evergreens	Improved Land 1880	Fertilizer per Acre 1909–10	Average Rank
Florida	91.5	2.7	$2.00	1½
South Carolina	80.0	21.2	2.49	4½
Georgia	77.4	21.8	1.37	7
New Hampshire	72.2	40.0	.55	13
Alabama	68.2	19.5	.79	7
Maine	68.0	18 3	1.72	4
Louisiana	65.6	9.4	.38	7½
Mississippi	55.3	17.6	.30	9½
North Carolina	51.5	20.8	1.39	5½
Delaware	41.5	59.4	1.21	14
Virginia	36.1	33.0	.70	11½
Vermont	35.9	56.3	.35	17
Wisconsin	34.6	25.9	.01	18
Arkansas	30.3	10.7	.07	12
New York	26.8	58.1	.48	17½
Pennsylvania	24.2	46.8	.54	14½
Michigan	19.8	22.6	.07	16
Maryland	19.0	52.0	1.01	13
West Virginia	13.5	24.7	.10	15
Missouri	6.9	38.1	.03	19
Tennessee	4.7	31.9	.11	15½
Kentucky	2.3	41.8	.09	18½
Ohio	0.5	69.3	.22	20
Indiana	0.1	60.6	.13	20

The departure of the last column from a numerical sequence indicates how far the evergreen percentages and soil fertility, *as determined from census statistics,* from which the personal equation is practically eliminated, fail to correspond. The average difference between these figures and what they should be if the correlation were perfect is only 2¾, whereas if there were no correlation at all the probable average difference would be two or three times as great. The correspondence is as close as could reasonably be expected under the circumstances; and moreover, some of the discrepancies are easily explained.

For example, in Maryland, North Carolina and Tennessee a large proportion of the deciduous forest is in mountainous regions, too rough for farming but not for lumbering, so that the true evergreen percentages are probably higher than the figures indicate. In Mississippi and Louisiana the deciduous trees are mostly in swamps, which also repel farmers more than lumbermen. In New Hampshire, Vermont, New York and Wisconsin conditions

[3] Some persons with whom the writer has discussed the matter during the past year pretend to believe that the amount of fertilizer used depends mainly on the enterprise of the farmers, but they would hardly contend that the farmers of South Carolina and Florida are ten times as enterprising as those of Ohio and Indiana!

are somewhat reversed, the evergreens being mostly in places unattractive to farmers, and the apparent percentages of them probably too high. The percentage of improved land in West Virginia and Arkansas is rather low, perhaps chiefly because these states are off the main routes of travel and have not received as many settlers as their soil would warrant. It is low in Mississippi and Louisiana on account of large areas of alluvial land, which although very rich (and originally wooded almost exclusively with deciduous trees) were very little cultivated in 1880 on account of being subject to overflow. In the northern states improved land includes a large proportion of pasture, on which no fertilizer is used, and if the amount of cultivated land could be substituted for improved land the fertilizer figures for these states would average considerably more per acre.

Finally, it can not be doubted that different chemical elements in the soil affect evergreen percentages and other features of vegetation unequally, and it is well known that the composition of rich soils varies greatly in different states. The soils of Florida are generally well supplied with calcium and phosphorus, but deficient in potassium, while in Illinois phosphorus is said to be the element most in danger of exhaustion. The average composition of fertilizers used varies from state to state, corresponding more or less with the soils (a larger proportion of potassium is used in Florida than in any other state), but no statistics of fertilizer ingredients are given in census reports; so that matter will not be taken up at the present time.

ROLAND M. HARPER

SPECIAL ARTICLES

STANDARD DAIRY SCORE CARDS

MR. JAMES D. DREW[1] presents data which should be of very general interest. The purpose of this note is to direct attention to these studies in the hope that they may receive the wide attention which they deserve. The most important result of such consideration would be the carrying out of even more comprehensive and exact studies of the same kind.

The problems taken up are essentially two:

a. What is the correlation between the grades assigned a series of dairies by the same inspectors when different score cards are used?

b. What is the correlation between the score assigned a dairy by an inspector and the quality of the milk which it places upon the market?

The first of these problems is of technical importance in determining the degree of reliability of the application of score cards to the grading of dairies. The second is fundamental to the determination of the utility of the score card in the grading of milk, and thus one of first rate practical significance to the consumer of dairy products.

For purposes of review it has seemed best to express the detailed observations in the succinct terms of statistical constants. The personal opinion of the reviewer that such statistical constants are better as a means of expressing the results than the mere comparison of individual points of detail, and his conviction that the analysis of the data in certain of its more refined essentials can be carried out only by such formulæ, must not be taken as a criticism of the data or their discussion in the paper under review.

With regard to the agreement between the three methods of grading, the authors confine their discussion to the relative positions of the individual dairies on the three score cards. The correlation coefficients[2] are illuminating. They are:

[1] Drew, J. D., "Milk Quality as Determined by Present Dairy Score Cards," *Bull. N. Y. Agr. Exp. Sta.*, 398, Geneva, March, 1915. The work was originally planned by Dr. H. A. Harding, and is now being carried out in cooperation with the Illinois Agricultural Experiment Station.

[2] Data for 34 barns are given. For 23 of these bacterial counts for morning milk as well as evening milk are available. As a precaution against arithmetical slips I have marked out the correlations between the results by the three cards for both the total series and the sub-series for which morning milk was available. The latter should be essentially a random sample of the former.